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FLOOD INSURANCE STUDY

CITY OF OCEAN SPRINGS
MISSISSIPPI
JACKSON COUNTY

MARCH 18, 1987

Federal Emergency Management Agency

COMMUNITY NUMBER - 285258

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NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program (NFIP) have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

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Flood Boundary and Floodway Map Index
Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map

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FLOOD INSURANCE STUDY

CITY OF OCEAN SPRINGS,
JACKSON COUNTY,
MISSISSIPPI

1.0 INTRODUCTION

1.1 Purpose of Study

The purpose of this Type 19 Flood Insurance Study is to investigate the existence and severity of flood hazards in the City of Ocean Springs, Jackson County, Mississippi, and to aid in the administration of the Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Initial use of this information will be to revise the Flood Insurance Rate Map developed from data presented in the Type 15 Flood Insurance Study. Further use of the information will be made by local and regional planners in their efforts to promote sound land use and floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by Gee & Jenson Engineers, Architects, Planners, Inc. (the Study Contractor) for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-C-0159. This study was completed in February 1985.

1.3 Coordination

Areas requiring detailed study were identified at a meeting on June 18, 1979, attended by representatives of the City of Ocean Springs, FEMA, and the Study Contractor. The legal announcement of the Flood Insurance Study and its purpose was placed in the "Mississippi Press Register" on November 10, 1980, the "Daily Herald" on November 13, 1980, and the "Ocean Springs Record" on November 20, 1980.

During the course of the study, contacts were maintained with Ocean Springs for general information and historical flood data. Contacts were also made with the following in an attempt to explore all possible sources of data: Gulf Regional Planning Commission; Harrison County Civil Defense Agency; Mississippi Geological Survey; Mississippi State Highway Department; National Ocean Survey (NOS); National Weather Service;

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National Aeronautics and Space Administration; U.S. Soil Conservation Service; U.S. Army Corps of Engineers (COE), Mobile District; COE, New Orleans District; COE, Vicksburg District; U.S. Geological Survey (USGS); and the Mississippi State Coordinator Office, Research and Development Center.

On July 7, 1986, the results of this Flood Insurance Study were reviewed and accepted at a final coordination meeting attended by representatives of the Study Contractor, FEMA, and the community.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Ocean Springs, Jackson County, Mississippi. The area of study is shown on the Vicinity Map (Figure 1).

Flooding caused by overflow of Old Fort Bayou, Biloxi Bay, Davis Bayou, and Mississippi Sound within the community was studied in detail.

The previous 1983 study included a detailed coastal flooding analysis, performed on the complete coastline of the City of Ocean Springs, where the flooding sources are Davis Bayou, Biloxi Bay, and Mississippi Sound. The results of the previous study remain unchanged and are incorporated herein.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards.

Approximate analyses were used to study several areas along Old Fort Bayou, Biloxi Bay, Davis Bayou, and Mississippi Sound.

The areas studied were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through September 1988. The scope and methods of study were proposed to and agreed upon by FEMA and the City of Ocean Springs.

2.2 Community Description

The City of Ocean Springs is located on the Mississippi Gulf Coast in Jackson County. The community is bounded on the west by Biloxi Bay, on the south by Davis Bayou, and on all other sides by the unincorporated areas of Jackson County. The city is located about 89 miles east of the City of New Orleans, Louisiana, and about 57 miles west of the City of Mobile, Alabama. According to the census, the population has reportedly increased from 9,580 in 1970 to 14,504 in 1980. This represents an increase of approximately 31 percent (Reference 1).

Primary east-west traffic in Ocean Springs is served by U.S. Highway 90. Interstate Highway 10, lying approximately 2 miles north of the community, now handles the burden of the traffic previously restricted to U.S. Highway 90. North-south access is provided by way of Washington Avenue, which extends northward from Beach Drive to Interstate Highway 10. Railroad service is provided by the Louisville & Nashville Railroad. General air service in the area is handled by the Gulf Central-Stennis International Airport. Major air carriers are accessible via Mobile and New Orleans

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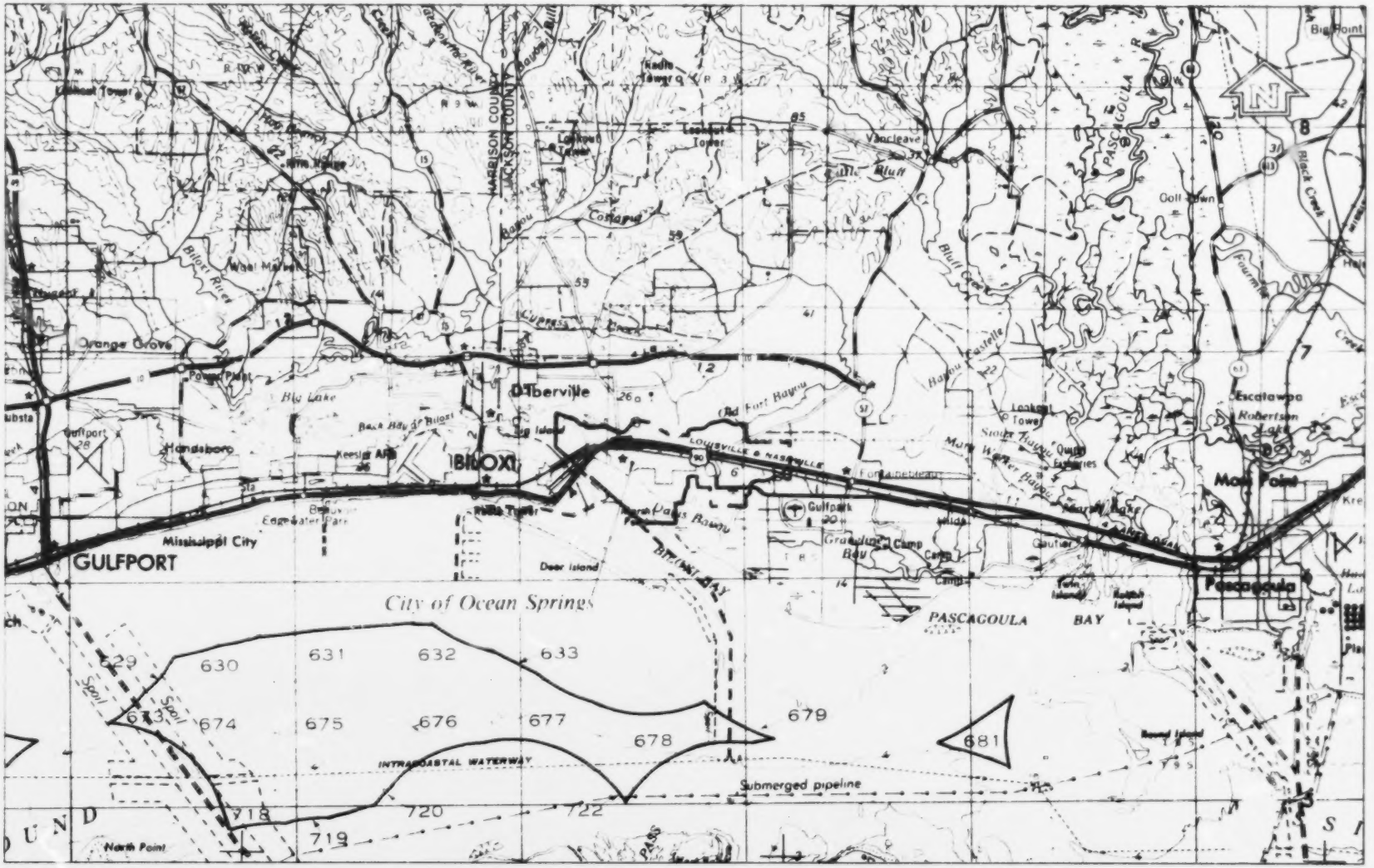

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF OCEAN SPRINGS, MS

(JACKSON CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

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International Airport. Keesler Air Force Base, located in the City of Biloxi, Mississippi, is a primary operation base for military aircraft activity.

The ports of Gulfport, Mississippi, Biloxi, and Pascagoula, Mississippi, provide mooring and transport facilities for large tonnage vessels into the area. The marina at Inner Harbor provides mooring facilities for the majority of commercial and private fishing vessels in the area.

The city is the historical site for the first permanent French settlement in the central area of North America. First known as Fort Maurepas, the name was later changed to Biloxi. In the early 1700s, Biloxi was moved across the bay to its present location, and in 1854 the original settlement officially became known as Ocean Springs. Named for the spring waters that were found there, the city became a health resort around the turn of the century.

Major industries in the community consist of apparel, concrete products, and ship building as well as tourism and commercial and private interests. The coastal strip of Ocean Springs, with the exception of an area between Weeks Bayou and Inner Harbor, is almost completely developed in residential home sites. Residential development extends northward to the east bank of Old Fort Bayou. Commercial development is centered along Washington Avenue and U.S. Highway 90. The recent completion of Interstate Highway 10 is expected to increase development, both residential and commercial, along the northern boundary of the community.

Topography in the community is generally high, reaching approximately 20 feet National Geodetic Vertical Datum of 1929 (NGVD). The inland influence of local bayous and their adjacent tributaries, however, creates a varied topography ranging from mean sea level to 20 feet NGVD. This pattern is consistent throughout the western portion of the community. Topography between Shearwater Drive and U.S. Highway 90 is generally flat, exhibiting elevations near 20 feet NGVD.

The climate in Ocean Springs is mild with mean annual temperatures between 65 and 70 degrees Fahrenheit (°F) (Reference 2). Average winter temperatures range from 53 to 60 °F with mean summer temperatures ranging from 75 to 82 °F. Rainfall averages approximately 62 inches annually, with the majority of accumulation in July through September. Winds in the area are southeasterly or southwesterly. Wind speeds usually remain under 10 mph, increasing during coastal storms.

The principal river system in the area is along Old Fort Bayou, which forms the northern corporate boundary of the city. This river extends from its headwaters, about 8 miles upstream of Interstate Highway 10, to about 18 miles to its confluence with Biloxi Bay north of Ocean Springs.

2.3 Principal Flood Problems

Coastal areas along Mississippi Sound, Biloxi Bay, and Davis Bayou are subject to coastal storm surge flooding and wave action as a result of hurricane and tropical storm activity in the gulf. Old Fort Bayou and the tributaries adjacent to local coastal bayous and drainage ways are also subject to coastal storm surge flooding and, to a lesser extent, from riverine

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flooding during periods of heavy rainfall. Severe rainfall can also cause flooding as a result of ponding in low-lying areas and areas with inadequate drainage.

Historical descriptions of past hurricanes and related damage are numerous for this area. During the 1800s, storms caused significant damage to the gulf coast (Reference 3). Figure 2, Historical Storm Tracks, shows the tracks of some of the more significant storms to enter the Gulf of Mexico since 1900.

Following are some of the more significant storms occurring in this century:

1909 (September 10-21)

Landfalling in Louisiana, the storm caused tides of 8 to 12 feet along the Mississippi coast. Three hundred and fifty lives were reported lost as a result of the storm (Reference 4).

1915 (September 22 - October 1)

This hurricane made landfall near the City of Grand Isle, Louisiana, on September 29. Although the storm center passed well west of the Mississippi coast, a pressure of 28.02 inches of mercury was recorded at Biloxi. High-water elevations ranged from 11.8 feet at the City of Bay St. Louis, Mississippi, to 9.0 feet at the City of Gulfport and Biloxi. Reportedly 275 lives were lost because of this storm (Reference 4).

1947 (September 4-21)

This hurricane entered the Gulf of Mexico after passing over Florida. Continuing across the gulf, the hurricane made landfall in southeast Louisiana on September 19. High-water marks surveyed after the storm showed elevations ranging from 8 feet at the City of Pascagoula to 15 feet at Bay St. Louis. Portions of the 28-mile seawall west of Pascagoula were breached during this storm. Fifty one people were left dead in its wake, with damages estimated at $100 million (Reference 4).

1965 Hurricane Betsy (August 27 - September 12)

Entering the Gulf of Mexico on September 8, Hurricane Betsy proceeded on a northwesterly track making landfall west of Grande Isle on the evening of September 9. Betsy left many sections of U.S. Highway 90 along the shoreline damaged as a result of wave action and surge. High-water elevations surveyed after the storm were about 12 feet in the vicinity of the Cities of Waveland, Mississippi, Bay St. Louis, and Pass Christian, Mississippi. The tide gage at Biloxi recorded a peak surge of 8.6 feet NGVD (approximately a 25-year recurrence interval) (References 5 and 6).

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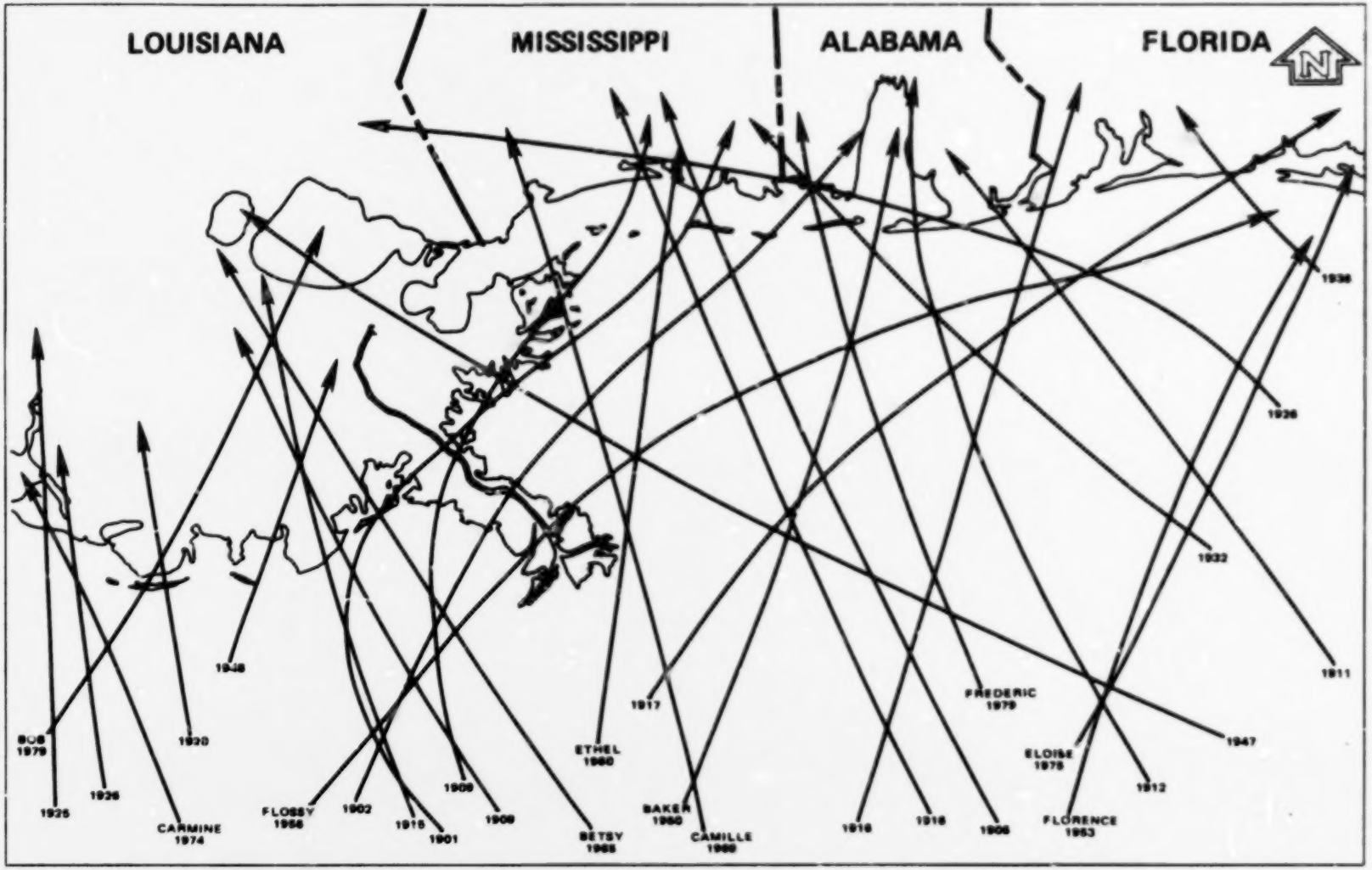

FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF OCEAN SPRINGS, MS

(JACKSON CO.)

APPROXIMATE SCALE

32 0 32 64 96 MILES

HISTORICAL STORM TRACKS (1900 - 1981)

1969 Hurricane Camille (August 14-22)

Camille reached hurricane strength on the morning of August 15, with estimated wind speeds of 90 mph near the center of the storm. The location of the storm was 75 miles off the extreme southwestern tip of Cuba. The storm continued to develop rapidly, while traveling on a north-northwest track.

Camille was located 155 miles southeast of New Orleans at 1:00 p.m. on August 17, and was tracking to the north-northwest at 12 to 15 mph. Maximum wind speeds were estimated at 160 mph, with Weather Bureau predictions of 190 mph for that same afternoon. The center of Camille passed to the east of the mouth of the Misssissippi River and then made landfall at Waveland and Bay St. Louis at 10:30 p.m., August 17. The eye was estimated to be 10 to 12 miles in diameter, and a central pressure of 26.85 inches of mercury was recorded in Bay St. Louis.

In Ocean Springs, high-water marks up to 15.8 feet NGVD were surveyed after the storm. Estimated wind speeds were 140 mph with gusts estimated at 175 mph. Camille ranked 5 on the Saffir/Simpson Hurricane Scale of 1 to 5, the most intense storm to ever hit the mainland of the United States (Reference 7).

2.4 Flood Protection Measures

Following the storms of 1909 and 1915, which damaged much of the coastal highway, a 28-mile protective seawall was constructed to prevent future damage. Completed in 1927, the seawall was the longest single concrete structure of its time. The seawall system in Ocean Springs is located in two sections along the south shore. The first section extends from Weeks Bayou to Halstead Road along Shearwater Drive. The second section extends from the U.S. Highway 90 bridge to Inner Harbor.

After the September hurricane of 1947, a manmade beach was placed seaward of the seawall to further attenuate damage along the coast. The seawall and beach system has been effective in minimizing wave damage north of the coastal highway. Deer Island offers some protection from wave action for Ocean Springs.

A storm drainage system consisting of natural and manmade ditches handles storm runoff for the less intense rainfall events.

Presently, new building construction is regulated by the city to an elevation of 13.1 feet NGVD.

A seawall exists in the study area that provides the community with some degree of protection against flooding. However, it has been ascertained that this seawall may not protect the community from rare events such as the 100-year flood. The criteria used to evaluate protection against the 100-year flood are 1) adequate design, including freeboard, 2) structural stability, and 3) proper operation and maintenance. Seawalls that do not protect against the 100-year flood are not considered in the hydraulic analysis of the 100-year floodplain.

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3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each riverine flooding source studied in detail affecting the community. Analyses were also carried out to establish the peak elevation-frequency relationships for each coastal flooding source studied in detail.

The flows of the required frequencies for Old Fort Bayou were based on a method presented in "Flood Frequency of Mississippi Streams" (Reference 8). This report outlined methods of determining the 10-, 40-, and 100-year discharges. The computed flows for the frequencies were then graphically extrapolated on log-probability paper to determine the 500-year discharges.

Peak discharges for the 10-, 50-, 100-, and 500-year floods of each riverine flooding source studied in detail in the community are shown in Table 1.

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQ MILES)	PEAK DISCHARGE (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
OLD FORT BAYOU at mouth	48.2	4,680	7,720	9,710	15,400

Inundation from Biloxi Bay, Davis Bayou, Old Fort Bayou, and Mississippi Sound caused by passage of storms (storm surge) was determined by the joint probability method (Reference 9). The storm populations were described by probability distributions of five parameters that influence surge heights. These were central pressure depression (which measures the

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intensity of the storm), radius to maximum winds, forward speed of the storm, shoreline crossing point, and crossing angle. These characteristics were described statistically based on an analysis of observed storms in the vicinity of Ocean Springs. Primary sources of data for this were "Tropical Cyclones of the North Atlantic Ocean, 1871-1977" (Reference 10), "Some Climatological Characteristics of Hurricanes and Tropical Storms, Gulf and East Coasts of the United States" (Reference 11), and "Meteorological Criteria for Standard Project Hurricane and Probable Maximum Hurricane Wind Fields, Gulf and East Coasts of the United States" (Reference 12), by the National Oceanic and Atmospheric Administration (NOAA). A summary of the parameters used for the area is presented in Table 2, Parameter Values for Surge Elevations.

For areas subject to flooding directly from Davis Bayou, Biloxi Bay, Old Fort Bayou, and Mississippi Sound, the FEMA standard storm surge model was used to simulate the coastal surge generated by any chosen storm (that is, any combination of the five storm parameters defined previously). By performing such simulations for a large number of storms, each of known total probability, the frequency distribution of surge height can be established as a function of coastal location. These distributions incorporate the large-scale surge behavior, but do not include an analysis of the added effects associated with much finer scale wave phenomena, such as wave height or runup. As the final step in the calculations, the astronomic tide for the region is then statistically combined with the computed storm surge to yield recurrence intervals of total water level (Reference 13).

The storm-surge elevations for the 10-, 50-, 100-, and 500-year floods have been determined for Ocean Springs and are shown in Table 3, Coastal Flood Insurance Zone Data. The analyses reported herein reflect the stillwater elevations due to tidal and wind setup effects and include the contributions from wave action effects.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the riverine sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Cross sections for the water-surface elevation analyses of Old Fort Bayou were obtained by field measurements (References 14 and 15). Bridges and culverts were field checked to obtain elevation data and structural geometry.

For stream segments for which a floodway was computed (Section 4.2), selected cross-section locations are shown on the Flood Boundary and Floodway Map.

Roughness factors (Manning's "n") used in hydraulic computations were chosen based on field observations of the stream and floodplain area. The roughness coefficients for the main channel of Old Fort Bayou ranged from 0.03 to 0.045, with floodplain roughness values ranging from 0.075 to 0.085 for all floods.

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CENTRAL PRESSURE (Inches of Mercury)	29.40	29.08	28.75	28.42	28.10	27.77	27.44	27.12
PROBABILITY	26%	26%	26%	10%	05%	05%	01%	01%
STORM RADIUS (Nautical Miles)	16			27				
PROBABILITY	52%			48%				
FORWARD SPEED (Knots)	7			11.5		16		
PROBABILITY	51%			28%		21%		
DIRECTION OF TRAVEL (Degrees Heading Clockwise (from North)	282.5		327.5		12.5		57.5	
PROBABILITY	10%		22%		37%		31%	
FREQUENCY OF OCCURRENCE	0.00333 STORMS PER NAUTICAL MILE PER YEAR							

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF OCEAN SPRINGS, MS
(JACKSON CO.)

PARAMETER VALUES FOR SURGE ELEVATION COMPUTATIONS

FLOODING SOURCE	TRANSECTS	PANELS	STILLWATER ELEVATIONS				FLOOD HAZARD FACTOR[1]	ZONE[2]	BASE FLOOD ELEVATION (FEET NGVD)[3]
			10-YR	50-YR.	100-YR	500-YR			
GULF OF MEXICO/ MISSISSIPPI SOUND	1	0001, 0002	6.7	9.8	11.1	13.5	070 050	V14 A10	13-14 12-13
	2	0001	6.8	9.9	11.2	13.6	070 055	V14 A11	13-14 11-13
	3, 4, 5	0001,0002,0006	6.9	10.0	11.3	13.7	070 055	V14 A11	13-16 11-13
	6, 7	0006	6.9	10.0	11.3	13.7	070 055	V14 A11	13-16 11-13
	8	0007	6.7	9.7	11.0	13.3	070 055	V14 A11	13-15 11-13
		0001,0002 0003,0004 0007,0008	–	–	–	–	045	A9	11

1 - Includes the effects of Wave Action, where applicable.

2 - Due to map scale limitations, Base Flood Elevations (BFEs) shown on the Flood Insurance Rate Map may represent average elevation for the zone depicted.

3 - Weighted Average Value.

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF OCEAN SPRINGS, MS

(JACKSON CO.)

COASTAL FLOOD INSURANCE ZONE DATA

GULF OF MEXICO/MISSISSIPPI SOUND

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Water-surface elevations of floods of the selected recurrence intervals of the streams studied in detail were computed through use of the COE HEC-2 step-backwater computer program (Reference 16). The starting water-surface elevations for Old Fort Bayou were calculated using the slope-area method, with exception of the 10-year frequency flood. The mean high tide elevation of 0.15 feet NGVD was used as the starting water-surface elevation for the 10-year frequency flood because the water-surface elevation computed by the slope-area method was lower than this.

The hydraulic analyses for the riverine study are based only on the effects of unobstructed flow. The flood elevations shown on the profiles are, thus, considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

Hydraulic analyses, considering storm characteristics and the shoreline and bathymetric characteristics of the flooding sources studied, were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of the shorelines.

Located on the coast, the City of Ocean Springs is primarily subject to coastal storm surge flooding from hurricanes and tropical storms. Detailed hydraulic analyses of the shoreline characteristics were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. FEMA standard coastal storm surge model (Reference 13) was utilized to determine these flood levels. This model is a numerical hydrodynamic computer model that calculates the coastal storm surges previously described in Section 3.1. Before applying the numerical model to the study area, several recent hurricanes that have affected the Mississippi coast were simulated for verification purposes. Surge elevations computed by the numerical model were compared to recorded tide gage heights at Biloxi and Dauphin Island, Alabama. The results are shown as follows:

Location	Storm	Elevation Computed by Numerical Model Plus Predicted Tide	Elevation Observed
Biloxi	Hurricane Betsy, 1965	8.8	8.6 (a)
Dauphin Island	Hurricane Camille, 1969	3.7	3.8 (b)

Sources: a) data from tide gage station, COE
b) data from tide gage station, U.S. Department of Commerce, NOAA, NOS

All elevations referenced in feet above NGVD.

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Both an open coast and a bay model were required for this study. The open coast model consisted of 5 nautical-mile square grids extending from the west shore of Lake Borgne to the City of Panama City, Florida, and offshore approximately 160 nautical miles. The bay model, consisting of 1 nautical-mile square grids, encompassed Mississippi Sound and the offshore barrier islands.

Water depths for the offshore areas were obtained from NOS bathymetric maps at a scale of 1:250000 and for nearshore areas from NOS hydrographic surveys with various dates and scales (References 17 and 18).

Land elevations for the models were obtained from USGS topographic maps (Reference 19).

Friction factors (Mannings "n") for inland areas were chosen based on aerial photographs flown in 1980 (Reference 20) and by field inspection in 1981.

In ponding areas, base flood elevations were determined based on a volumetric rainfall-runoff relationship by estimating the stage that would be reached using the available topography and the 100-year rainfall event.

The methodology for analyzing the effects of wave heights associated with coastal storm surge flooding is described in a report prepared by the National Academy of Sciences (Reference 21). This method is based on the following major concepts. First, depth-limited waves in shallow water reach a maximum breaking height that is equal to 0.78 times the stillwater depth. The wave crest is 70 percent of the total wave height above the stillwater level. The second major concept is that wave height may be diminished by dissipation of energy due to the presence of obstructions, such as sand dunes, dikes and seawalls, buildings, and vegetation. The amount of energy dissipation is a function of the physical characteristics of the obstruction and is determined by procedures prescribed in Reference 21. The third major concept is that wave height can be regenerated in open fetch areas due to the transfer of wind energy to the water. This added energy is related to fetch length and depth.

Wave heights were computed along transects (cross-section lines) that were located along the coastal areas, as illustrated in Figure 3, Transect Location Map, in accordance with the "Users Manual for Wave Height Analysis" (Reference 22). The transects were located with consideration given to the physical and cultural characteristics of the land so that they would closely represent conditions in their locality. Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, they were spaced at large intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects.

Each transect was taken perpendicular to the shoreline and extended inland to a point where wave action ceased. Along each transect, wave heights and elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. The stillwater elevations for the 100-year flood were used as the starting elevations for these computations. Wave heights were calculated to the nearest 0.1 foot,

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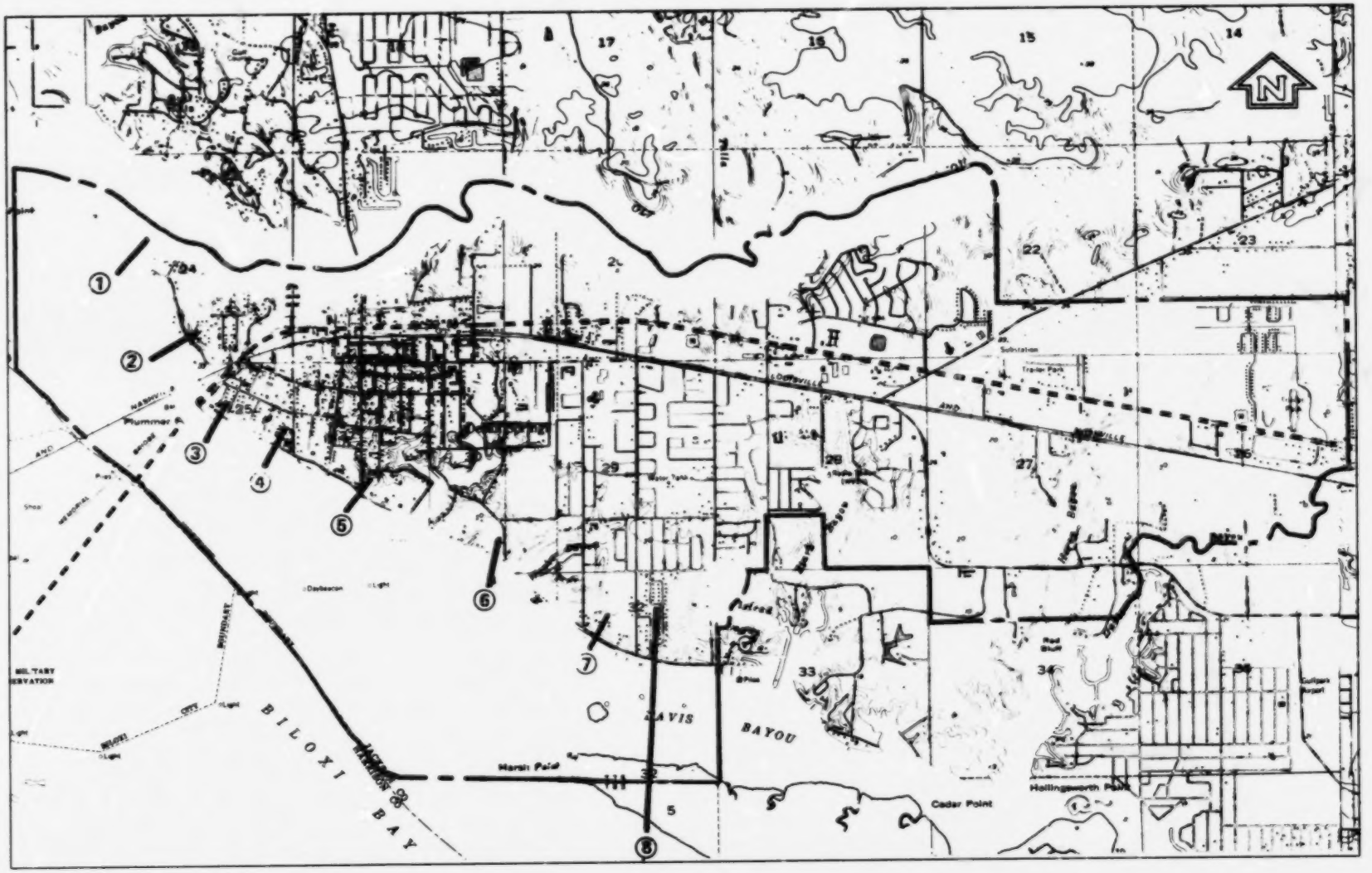

FIGURE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF OCEAN SPRINGS, MS
(JACKSON CO.)

TRANSECT LOCATION MAP

and wave elevations were determined at whole-foot increments along the transects. The location of the 3-foot breaking wave for determining the terminus of the V zone (area with velocity wave action) was also computed at each transect. Table 4 provides a listing of the transect locations and stillwater starting elevations, as well as initial wave crest elevations.

Figure 4 represents a sample transect that illustrates the relationship between the stillwater elevation, the wave crest elevation, the ground elevation profile, and the location of the A/V zone boundary.

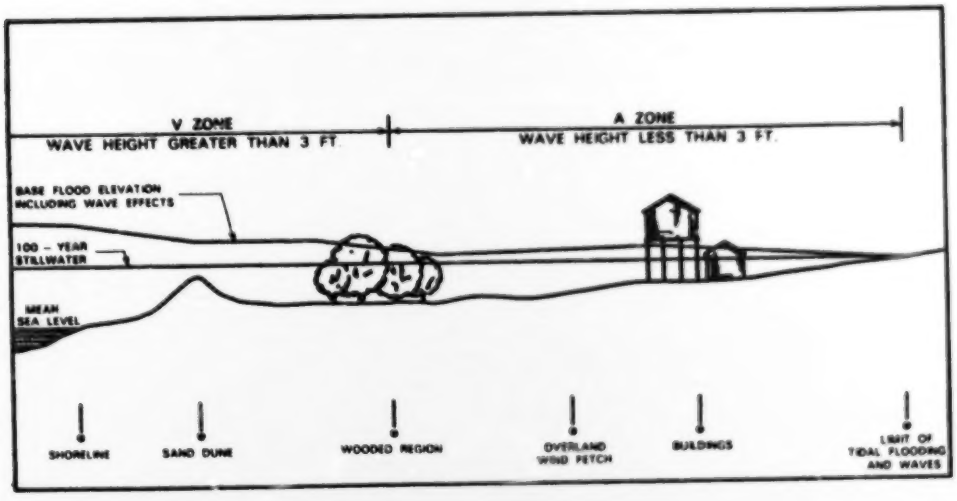

FIGURE 4 - Transect Schematic

After analyzing wave heights along each transect, wave elevations were interpolated between transects. Various source data were used in the interpolation, including topographic maps (Reference 23), aerial photographs (Reference 24), and engineering judgment. Controlling features affecting the elevations were identified and considered in relation to their positions at a particular transect and their variation between transects.

All elevations are referenced to the NGVD. Elevation reference marks used in this study are shown on the maps.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing floodplain management measures.

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TABLE 4 - TRANSECT LOCATIONS, STILLWATER STARTING ELEVATIONS, AND INITIAL WAVE CREST ELEVATIONS

Transect	Location	Elevation (Feet) Stillwater	Wave Crest
1	located on northwest peninsula of Ocean Springs, between Ponchartrain Court and Father Davion Court	11.1	14.3
2	located on northwest peninsula of Ocean Springs, about 1,200 feet north of Louisville & Nashville Railroad crossing over Biloxi Bay	11.2	14.4
*3	located along Front Beach Drive, about 250 feet southeast of the intersection with Hillandale Avenue	11.3	15.8
*4	located along Front Beach Drive, about 450 feet northwest of the intersection with Martin Avenue	11.3	15.8
*5	located along Front Beach Drive, about 100 feet northwest of the intersection with Washington Avenue	11.3	15.7
*6	located about 500 feet northwest of the East Beach Bridge over Weeks Bayou along Shearwater Drive	11.3	15.6
*7	located along Shearwater Drive, about 400 feet southeast of the intersection with Holcomb Boulevard	11.3	15.6
8	located on Marsh Point about 450 feet southeast from the tip of the point and across Davis Bayou from San Souci Avenue	11.0	17.0

*transect begins initially at Deer Island - elevations represent wave crests at shoreline of Ocean Springs, not Deer Island

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:3600 with a contour interval of 1 foot (References 23 and 24). For each coastal flooding source studied in detail, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each transect. Between transects, the boundaries were interpolated using the above-mentioned topographic maps (References 23 and 24).

Floodplain boundaries are indicated on the Flood Insurance Rate Map. On this map, the 100-year floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zone A, numbered A zones, and numbered V zones) and the 500-year floodplain boundary corresponds to the boundary of areas of moderate flood hazards (Zone B). In cases where the 100- and 500-year floodplain boundaries are close together, only the 100-year floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces the flood-carrying capacity, increases the flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 100-year floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the floodplain. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed and are presented in Table 5, Floodway Data.

As shown on the Flood Boundary and Floodway Map, the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and the 100-year floodplain boundaries are either close together or collinear, only the floodway boundary has been shown. Portions of the floodway of Old Fort Bayou lie outside the corporate limits.

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH[4] (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY[2] (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
OLD FORT BAYOU								
A	10,001	1239	9363	1.0	11.0[3]	2.9	3.8	0.9
B	18,172	300	4203	2.3	11.0[3]	3.3	4.1	0.8
C	30,072	270	3629	2.7	11.0[3]	4.3	5.0	0.7

[1]FEET ABOVE MOUTH
[2]ELEVATIONS WITHOUT CONSIDERING STORM SURGE FROM BAY OF BILOXI
[3]COASTAL STORM SURGE EFFECT FROM BACK BAY OF BILOXI
[4]WIDTH EXTENDS BEYOND CORPORATE LIMITS

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF OCEAN SPRINGS, MS

(JACKSON CO.)

FLOODWAY DATA

OLD FORT BAYOU

The area between the floodway and the 100-year floodplain boundaries is termed the floodway fringe. The floodway fringe thus encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 5.

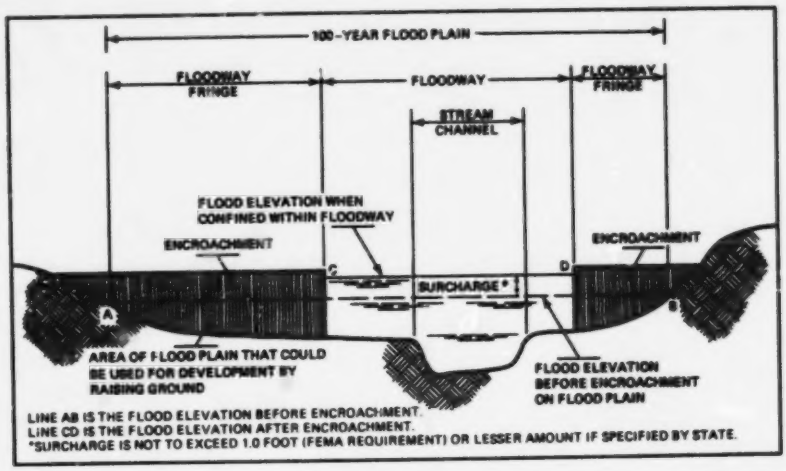
100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT.
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT.
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

FIGURE 5 - Floodway Schematic

The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail affecting the City of Ocean Springs.

5.1 Reach Determinations

For riverine studies, reaches are defined as sections of floodplain that have relatively the same flood hazard, based on the weighted average difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following table for more than 20 percent of the reach:

Average Difference Between 10- and 100-year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

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The locations of the reaches determined for the riverine flooding sources of the City of Ocean Springs are summarized in Table 6, Flood Insurance Zone Data.

In coastal areas, reaches are limited to the distance for which the 100-year flood elevation does not vary more than 1.0 foot. The location of these reaches are shown on the Flood Insurance Rate Map.

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a riverine reach is the weighted average difference between the 10- and 100-year flood water-surface elevations rounded to the nearest 0.5 foot, multiplied by 10, and shown as a 3-digit code.

The FHF for areas subject only to storm surge flooding is the difference between the 10- and 100-year stillwater elevations rounded to the nearest 0.5 foot, multiplied by 10, and shown as a 3-digit code. For areas with wave heights less than 3 feet, the FHF is the weighted average difference between the 100-year wave crest elevation and the 10-year stillwater elevation. For areas with wave heights greater than 3 feet, the FHF is determined using the difference between the 10- and 100-year stillwater elevations multiplied by 1.55, then rounded to the nearest 0.5 foot, multiplied by 10, and shown as a 3-digit code.

For example, if the difference between elevations is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference is greater than 10.0 feet, it is rounded to the nearest whole foot.

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations are shown or FHFs determined.
Zone AH:	Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; base flood elevations are shown, but no FHFs are determined.

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Zones A9-A11:	Special Flood Hazard Areas inundated by the 100-year flood, with base flood elevations shown, and zones subdivided according to FHFs.
Zone V14:	Special Flood Hazard Areas along coasts inundated by the 100-year flood that have additional velocity hazards associated with waves of 3-foot amplitude or greater, with base flood elevations shown, and zones subdivided according to FHFs.
Zone B:	Areas between Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- and 500-year floods by dike, levee, or other water control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and, areas subject to 100-year flooding from sources with drainage areas of less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding; not subdivided.

Flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community are shown in Table 6, Flood Insurance Zone Data, and Table 3, Coastal Flood Insurance Zone Data.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Ocean Springs is, for insurance purposes, the principal product of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines for riverine flooding sources show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. For coastal flooding sources, the expected water-surface elevations of the base (100-year) flood are shown as a weighted average within zones. Each whole-foot elevation is delineated except where cartographic considerations require the combination of two or more elevation zones. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

6.0 OTHER STUDIES

A study is in progress for the Unincorporated Areas of Jackson County (Reference 25) and is in agreement with this study.

For initial participation in the regular Flood Insurance Program, Ocean Springs was regulated at 13.1 feet NGVD. This elevation represented the 100-year water level

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3]
		10% (10 YR.)	4% (50 YR.)	0.2% (500 YR.)			
SHALLOW FLOODING	0003	*	*	*	*	AH	20
	0004	*	*	*	*	AH	19
	0006	*	*	*	*	AH	15
	0007	*	*	*	*	AH	14
	0007	*	*	*	*	AH	15
	0008	*	*	*	*	AH	17

1 - Flood Insurance Rate Map Panel
2 - Weighted Average
3 - Rounded to Nearest Foot - See Map
*Not Determined for Shallow Flooding

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF OCEAN SPRINGS, MS
(JACKSON CO.)

FLOOD INSURANCE ZONE DATA

SHALLOW FLOODING

as derived from a statistical evaluation of tidal records and high-water marks and the City of Biloxi, Mississippi, since 1982. The current study, which includes wave action, sets elevations ranging from 16 feet in Mississippi Sound to 11 feet in the bayou areas. The difference in elevations arises because of a refinement in methodology in determining stillwater elevations and the inclusion of waves.

Due to its more detailed analysis, this Flood Insurance Study supersedes the previously published Flood Insurance Study for the City of Ocean Springs (Reference 26).

7.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, 1371 Peachtree Street, NE., Suite 736, Atlanta, Georgia 30309.

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